FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

August 26, 2020

RE: Public Notice, *FCC Seeks Comment and Data on Actions to Accelerate Adoption and Accessibility of Broadband-Enabled Health Care Solutions and Advanced Technologies,* **GN Docket No. 16-46**

In light of the increasing importance of broadband connectivity in the Nation's response to the ongoing public health crisis occasioned by COVID-19 and the Commission's continuing focus on taking proactive steps in this area, the FCC's Connect2Health Task Force is including its pre-publication, staff research monograph titled "Broadband Connectivity: A 'Super' Determinant of Health" (dated May 28, 2019) as part of the above-referenced docket.

This research study looked at the relationship between the level of connectivity in a community and that community's health, and whether increasing broadband connectivity in a community correlates to improved health outcomes at the community and population levels. The analysis used diabetes prevalence data (now a risk factor for severe illness from COVID-19)[1] and broadband data (as of December 2015). The results suggest that there is a distinct correlation between increasing broadband access and improved health outcomes, and that Internet adoption appears to have an even greater correlation to improved health outcomes.

While additional research is certainly warranted, the Task Force believes that there is ample evidence to conclude that broadband connectivity is a "social determinant of health," one of the key environmental factors that determine the health of communities. In addition, the Task Force determined that because other established social determinants of health, such as education, employment opportunities, and job training, are increasingly premised on the availability of connectivity, broadband connectivity is not only a social determinant of health, but in its role as a gateway to other social determinants of health, it can be rightly thought of as a *super determinant of health*.

As part of its overall mission to explore the intersection of broadband, advanced technology, and health, the Task Force staff conducts targeted research and data analytics projects. The attached pre-publication manuscript is one such project. This research monograph was also distributed during the May 28, 2019, Senior Leadership Think Tank forum that was held as part of the Task Force's L.A.U.N.C.H. initiative.[2] Part of the discussion during the forum referenced emerging evidence demonstrating the impact of broadband—access and adoption—as a social determinant of health. The Task Force continues its deep

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[1] *See* CDC, People with Certain Medical Conditions, https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html#:~:text=Having%20type%202%20diabetes%20increases,from%20COVID%2D19 ("Having type 2 diabetes increases your risk of severe illness from COVID-19.").

[2] *See* FCC, Connect2Health Task Force, Senior Leadership Think Tank, https://www.fcc.gov/health/cancer/senior-leadership-think-tank.

dive into this critical policy issue, in close coordination with sister agencies and other relevant stakeholders.

Suggested citation: "Broadband Connectivity: A 'Super' Determinant of Health," Staff Research Monograph, Connect2Health[FCC] Task Force, Federal Communications Commission, May 23, 2019.

Please visit the Task Force's website at www.fcc.gov/health

Pre-Publication Version – 5/28/19

BROADBAND CONNECTIVITY: A "SUPER" DETERMINANT OF HEALTH

"There's this principle in social informatics that the internet is more than just a tool. It's more than just a device. It has this social connectivity, and it has this other thing where it sort of collapses distance. And so things come very, very close to you immediately in a way that never happened before."
Dr. Adam Perzynski, Ph.D., Assistant Professor of Medicine, Case Western Reserve University

Key Takeaways

- Broadband connectivity is a "social determinant of health," one of the key environmental factors that determine the health of communities. In addition, other established social determinants of health including education, employment opportunities, and job training, are increasingly premised on the availability of connectivity. This leads to the conclusion that connectivity is not only a social determinant of health, but in its role as a gateway to other social determinants of health, it can be rightly thought of as a "*super" determinant of health.*
- There is a distinct correlation between increasing broadband access and improved health outcomes. Based on December 2015 data, counties in any quintile of broadband access had on average 9.6% lower diabetes prevalence than those counties in the next lower quintile of access. This change in diabetes prevalence remained when we controlled for education (8.7%) and income (8.4%) separately or together with age (6.0%).
- Internet *adoption* appears to have an even greater correlation to improved health outcomes. Communities in a given quintile of Internet adoption on average had 16.5% lower diabetes prevalence compared to communities in the next lower quintile.
- Even in counties with the highest diabetes rates (the so-called, "diabetes belt" counties), where one might expect it to be more difficult to see an impact, increasing quintiles of broadband access correlated to decreasing rates of diabetes prevalence – 3.8% lower diabetes (and 1.8% and 2.0% respectively when corrected for education and income).

According to the Centers for Disease Control and Prevention and the World Health Organization, the building blocks of health include the conditions in which people live, learn, work, and play.[1] These so-

[1] *See* Centers for Disease Control and Prevention, Social Determinants of Health: Know What Affects Health, Frequently Asked Questions, https://www.cdc.gov/socialdeterminants/faqs/#faq6 (last visited May 9, 2018). *See also* Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services, Social Determinants of Health ("Our health is also determined in part by access to social and economic opportunities; the resources and supports available in our homes, neighborhoods, and communities; the quality of our schooling; the safety of our workplaces; the cleanliness of our water, food, and air; and the nature of our social interactions and relationships. The conditions in which we live explain in part why some Americans are healthier than others and why Americans more generally are not as healthy as they could be."), https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health (last visited May 9, 2018).

called "social determinants of health" are the environmental contexts that shape and sustain the health of individuals and communities and include access to education, job training, and employment opportunities.[2] The analysis below indicates that broadband connectivity is one of these building blocks of health. Broadband connectivity, both access and adoption, appears to have both a strong correlation to health outcomes at the population and community levels, and also an outsized effect on existing social determinants of health as well. To put it another way, we believe that broadband connectivity is a "*super" determinant of health*, impacting health in its own right while simultaneously serving as a gateway to address other established determinants of health like education, income, and employment.

Based on both empirical and experiential data, there is little remaining doubt that the use of connected health technologies can improve many targeted health outcomes for individuals. For example, studies have shown the effectiveness of various connected technologies in reducing mortality and hospitalization in persons with heart failure;[3] expanding access to health care for patients with limited access to a primary care provider;[4] decreasing loneliness and increasing social contact among older adults;[5] and improving various outcomes for patients with diabetes including short-term improvements in glycemic control.[6]

What has been less clear, until now, is the relationship between the level of connectivity in a community and that community's health and whether increasing broadband connectivity in a community correlates to improved health outcomes at the community and population levels. A "community-level" examination of connectivity and health is important because it can help us better evaluate connectivity as part of the

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[2] *See* Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services, Social Determinants of Health, https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health (last visited May 9, 2018); Centers for Disease Control and Prevention, Social Determinants of Health: Know What Affects Health, https://www.cdc.gov/socialdeterminants/ (last visited May 9, 2018); National Research Council (US), Institute of Medicine (US), Woolf SH, Aron L, editors, U.S. Health in International Perspective: Shorter Lives, Poorer Health (2013), *available at* https://www.ncbi.nlm.nih.gov/books/NBK154491/.

[3] *See* Calvin KL Or, Da Tao, Hailiang Wang, *The effectiveness of the use of consumer health information technology in patients with heart failure: A meta-analysis and narrative review of randomized controlled trials*, 23 Journal of Telemedicine and Telecare 155 (2017) (concluding that the use of consumer health information technology reduced the risk of HF-caused mortality, lowered the risk of HF-caused hospitalization, and shortened HF-caused length of hospital stay). *See also* Abdullah Pandor, Tim Gomersall, John W. Stevens, Jenny Wang, Abdallah Al-Mohammad, Ameet Bakhai, John GF Cleland, Martin R. Cowie, and Ruth Wong, *Remote monitoring after recent hospital discharge in patients with heart failure: a systematic review and network meta-analysis*, 99 Heart 1717 (2013) (concluding that compared with usual care, remote monitoring strategies tended to reduce all-cause mortality).

[4] *See* Lori Uscher-Pines, Ateev Mehrotra, *Analysis of Teladoc use seems to indicate expanded access to care for patients without prior connection to a provider*, 33 Health Affairs 258 (2014) (noting that patients who used Teladoc's telehealth services were less likely to have a follow-up visit to any setting, compared to those patients who visited a physician's office or emergency department, and suggesting that telehealth appears to be expanding access to patients who are not connected to other providers).

[5] *See* Shelia R. Cotten, William A. Anderson, Brandi M. McCullough, *Impact of Internet use on loneliness and contact with others among older adults: cross-sectional analysis*, 15 JMIR (2013) (concluding that using the Internet may be beneficial for decreasing loneliness and increasing social contact among older adults in assisted and independent living communities).

[6] *See* Calvin KL Or, Da Tao, *Does the use of consumer health information technology improve outcomes in the patient self-management of diabetes? A meta-analysis and narrative review of randomized controlled trials*, 83 International JMIR 320 (2014) (concluding that the use of consumer health information technology appears to have potential benefits for patients' self-management of diabetes).

environmental context that influences and sustains health.

We acknowledge and applaud previous efforts in this area.[7] Our analysis is groundbreaking in terms of putting all the pieces together and comprehensively analyzing the data at the intersection of broadband access/adoption and health outcomes. While previous efforts have examined and established the direct relationship between the use of connected technologies and health outcomes, and other studies have looked at specific aspects of Internet use and health behaviors and outcomes, to the best of our knowledge, none have clarified the relationship between a community's level of connectivity and its health status.

Increasing Connectivity, Improving Health

Our initial analysis has three key parts: (i) the correlation between health outcomes and broadband *access*; (ii) the correlation between health outcomes and broadband *adoption*; and (iii) to test those findings, a targeted look at both access and adoption in critical subpopulations – i.e., rural counties and counties with high levels of diabetes. The data for this analysis was drawn from various sources, including FCC Form 477 data on broadband access and subscribership as of December 2015.[8]

Access. First, we modeled the changing levels of broadband access (by quintile, i.e., 0-20%, 20-40% etc.) alongside diabetes prevalence.[9] We found that counties in any quintile of broadband access had on average 9.6% lower diabetes prevalence than those counties in the next lower quintile. To better illustrate, take County A with broadband access in the 40-60% range, and County B with broadband

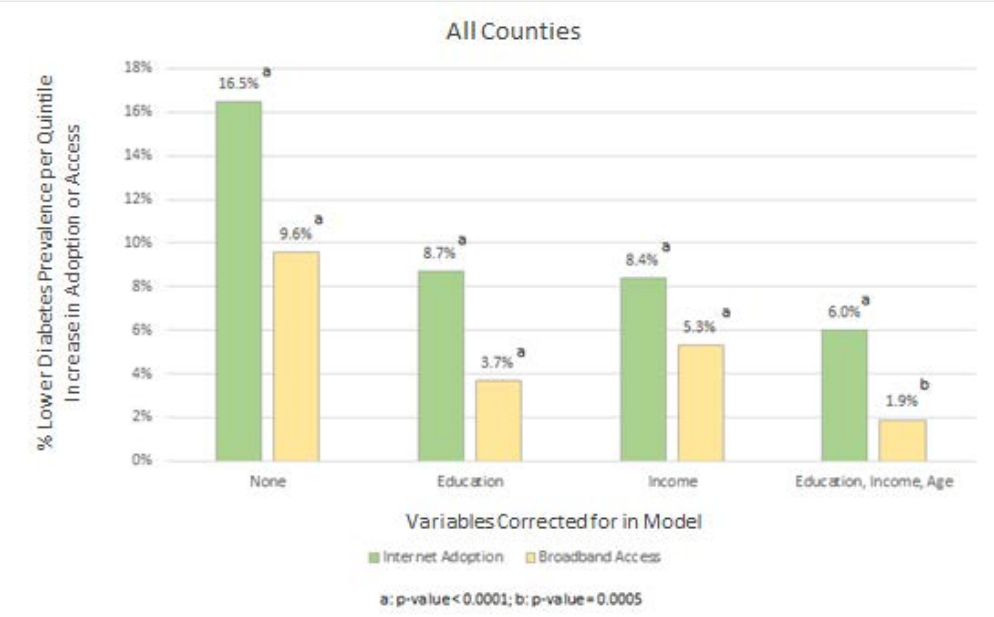
[7] We note that connectivity has been referenced peripherally and in a press article as a social determinant of health. *See, e.g.*, Jane Sarasohn-Kahn, *Broadband Connectivity Is A Social Determinant Of Health* (Jul. 23, 2017), https://www.huffingtonpost.com/jane-sarasohnkahn/broadband-connectivity- is_b_11059720.html. In addition, academic publications have flirted with portions of the concept. *See, e.g.*, Adam T Perzynski, Mary Joan Roach, Sarah Shick, Bill Callahan, Douglas Gunzler, Randall Cebul, David C Kaelber, Anne Huml, John Daryl Thornton, Douglas Einstadter, *Patient portals and broadband internet inequality*, 24 J Am Med Inform Assoc. 927 (2017); Ilana Graetz, Nancy Gordon, Vick Fung, Courtnee Hamity, Mary E. Reed, *The Digital Divide and Patient Portals: Internet Access Explained Differences in Patient Portal Use for Secure Messaging by Age, Race, and Income*, 54 Med Care. 772 (2016); Michael C. Gibbons, Renee F. Wilson, Lipika Samal, Christoph U. Lehmann, Kay Dickersin, Harold P. Lehmann, Hannan Aboumatar, Joseph Finkelstein, Erica Shelton, Ritu Sharma, Eric B Bass, *Consumer health informatics: results of a systematic evidence review and evidence based recommendations*, 1 Behav. Med. Pract. Policy Res. 72 (2011). *See also* American Medical Informatics Association Comments in GN Docket No. 16-46 (AMIA Comments).

[8] In conducting this analysis, we utilized the most recent data available for diabetes (*see* Centers for Disease Control and Prevention, CDC's Interactive Diabetes Atlas, https://www.cdc.gov/diabetes/data/county.html (last visited May 9, 2018), connectivity (i.e., FCC's Form 477 (as of December 31, 2015 data)), and demographic data (i.e., percent of population of college-educated consumers from American Community Survey (2011-2015); median household income data from Small Area Income and Poverty Estimates (2015); and percent of population 65 years and older from census population estimates (2015)). We note that, at the time of our analysis, the most recent diabetes data was from 2013, which is within two years of the broadband data used for the analysis. Based on prior years, we expect the prevalence of diabetes in the U.S. to have increased only incrementally during the relevant period and anticipate that the patterns detected and inferences made using the 2013 data remain valid. While diabetes prevalence in the U.S. is increasing, the rate of increase is low enough that past data has not shown dramatic increases in prevalence in a span of two years. For example, according to the CDC's BRFSS survey, the diabetes national prevalence for 2013 was 9.7 and in 2011 it was 9.5, an incremental increase of 0.2 points. *See* Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health, BRFSS Prevalence & Trends, https://www.cdc.gov/brfss/brfssprevalence/ (last visited May 10, 2018).

[9] *See* Table 1 ("Why Focus on Broadband and Diabetes"), *infra.*

access in 20-40% range. The data indicates that County A had diabetes prevalence that is 10% lower than County B. The difference in diabetes prevalence remained, even when controlled for potentially confounding factors like education (3.7%) and income (5.3%), independently, or together with age (1.9%). (*See* Figure 1).

Figure 1: All Counties — % Reduction in Diabetes Prevalence as Broadband Access and Internet Adoption Increase[10]



[10] Simply stated, p-values represent the probability of a given result occurring by chance over a series of repeated testing. In general, the lower the p-value the lower the probability that a given result occurred by chance. In Figures 1, 2, and 3, the p-value represents the probability that the percent reduction in diabetes prevalence between strata of broadband access or Internet adoption is occurring by chance in the statistical model.

TABLE 1: WHY FOCUS ON BROADBAND AND DIABETES?

While there are many health outcomes that could be considered, the cost and care burden of chronic disease nationwide is vast and growing. Therefore, we focus on broadband and chronic diseases and will use diabetes as a proxy. Diabetes is a serious, common, costly, yet manageable disease. According to the American Diabetes Association, in 2017, diabetes cost the nation an estimated $327 billion in direct and indirect costs. It is one of the top 10 leading causes of death in the United States and affects almost 26 million Americans, with 18.8 million people diagnosed and an additional 7 million people still undiagnosed.

People with diabetes face an array of health issues. It is the leading cause of lower-limb amputation not related to trauma, new cases of blindness, and kidney failure in the United States. It also is a major contributor to cardiovascular disease, the number one cause of death in this country. About 68% of people with diabetes die from cardiovascular disease. These current data tell an urgent story about the high rates of diabetes in the United States, reflecting the need to integrate all relevant specialties (e.g., pharmacy, podiatry, optometry, and dentistry providers) into the health care team to deliver high-quality, integrated care.

In addition, diabetes functions as a proxy for many other chronic conditions (e.g., obesity, hyperlipidemia, hypertension) whose environmental and lifestyle risk factors can be targeted using connected health interventions (e.g., fitness and healthy eating applications) to prevent their onset, or which can be managed using connected platforms (e.g. continuous glucose monitoring and remote patient management platforms) to reverse the diagnosis or prevent further sequelae, complications, or morbidity (e.g., kidney disease, blindness from retinopathy, limb loss and amputations from neuropathy and vascular disease), and mortality.

Sources: American Diabetes Association, *Economic Costs of Diabetes in the U.S. in 2017.* Diabetes Care, American Diabetes Association, 2018. Centers for Disease Control and Prevention, *National diabetes fact sheet, 2011. Fast facts on diabetes,* Atlanta, GA; Department of Health and Human Services; 2011.

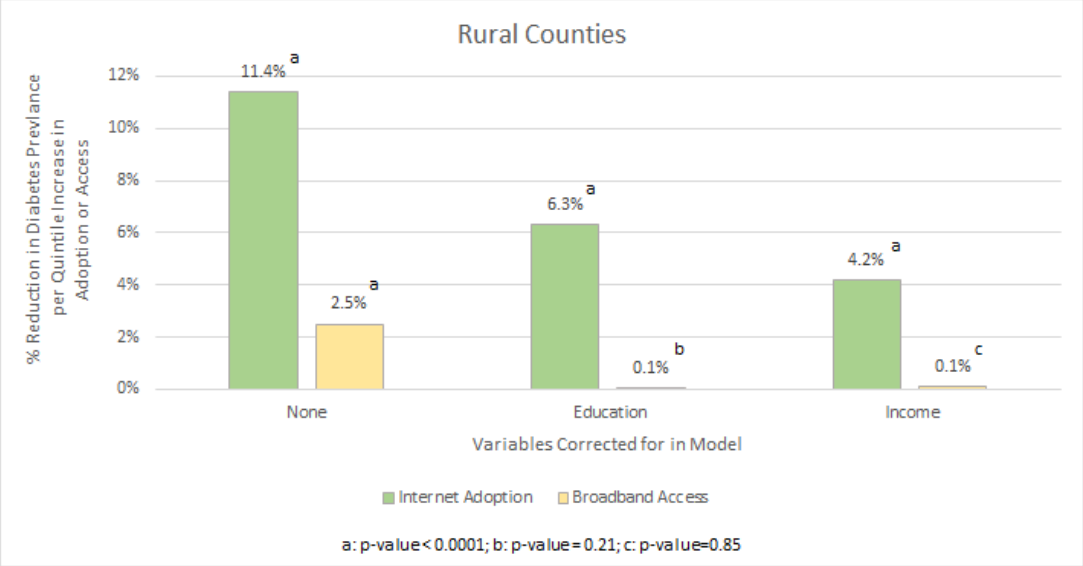
Methodology. The methodology underlying our analysis of broadband and diabetes is as follows:

- Determining the distribution of connectivity and diabetes prevalence across populations (e.g., rural versus urban).
- Determining the difference (if any) in diabetes prevalence with increases or decreases in connectivity first using an uncorrected linear regression model, and then using a model corrected for education and income independently, and also corrected for education, income, and age.
- Conducting a sub-sample analysis of counties with majority rural populations (which are typically the counties that have the worst connectivity metrics), again in an uncorrected model, and then a model corrected for education and income independently.
- Conducting a sub-sample analysis of high-diabetes counties, the so-called "diabetes belt" counties, (which are typically the counties that have the worst health outcomes including the highest prevalence of diabetes), in an uncorrected model, and separately a model corrected for education and income, independently.
- Calculating diabetes prevalence of a county in the lowest tier of connectivity then modeling its diabetes prevalence in higher tiers of connectivity as a way to visualize the differences in diabetes prevalence along a continuum of increasing connectivity levels.
- Offering an analytical framework for the connected-health ecosystem (the Connectivity Continuum) and presenting findings from research examining the various confounders between connectivity and health and the extent of their dependence on connectivity.

Adoption. Broadband adoption appears to have an even greater correlation to improved health outcomes. Communities in a given quintile of broadband adoption on average had 16.5% lower diabetes prevalence compared to communities in the previous quintile. This decrease in prevalence remained when we controlled for education (8.7%) and income (8.4%) separately or together with age (6.0%). (*See* Figure 1).

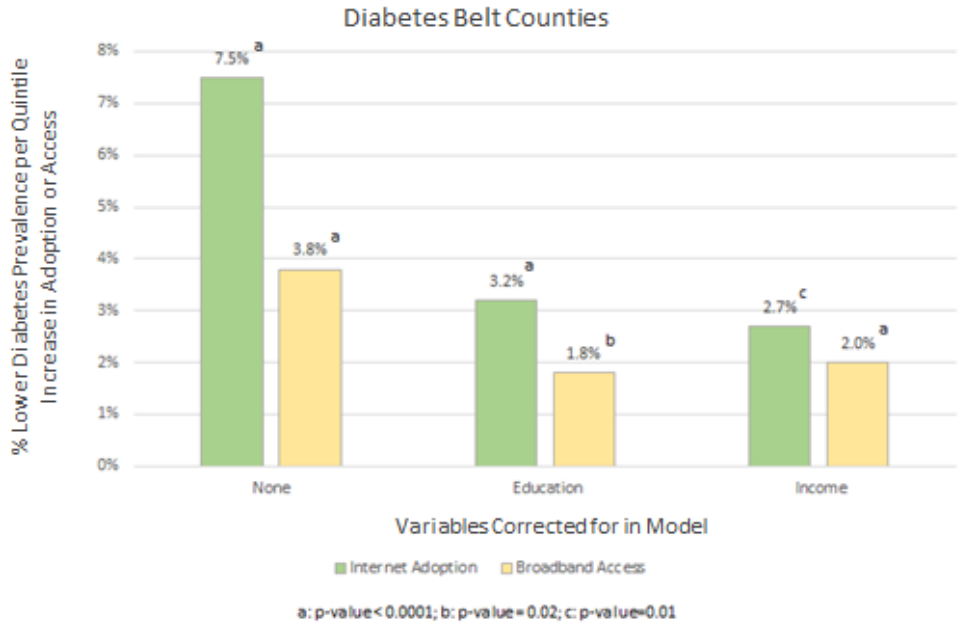
Rural Counties. For rural counties, we again see a similar same pattern: in this case, a 2.5% decrease in diabetes prevalence between quintiles of access and an 11.4% decrease between quintiles of adoption (0.1% and 6.3%, respectively, corrected for education; and 4.2% and 0.1%, respectively, when corrected for income). (*See* Figure 2).

Figure 2: Rural Counties — % Reduction in Diabetes Prevalence as Broadband Access and Internet Adoption Increase



High Diabetes Areas. Even in counties with the highest diabetes rates (the so-called, "diabetes belt" counties), where one might expect it to be more difficult to see an impact, increasing quintiles of broadband access correlated to decreasing rates of diabetes prevalence—3.8% lower diabetes (and 1.8% and 2.0%, respectively, when corrected for education and income). Again, increasing levels of Internet adoption showed an even greater change. In "diabetes belt" counties with higher levels of Internet adoption, diabetes prevalence was lower by 7.5% (3.2% and 2.7%, respectively, when corrected for education and income) (*See* Figure 3).

Figure 3: High Diabetes Counties — % Reduction in Diabetes Prevalence as Broadband Access and Internet Adoption Increase



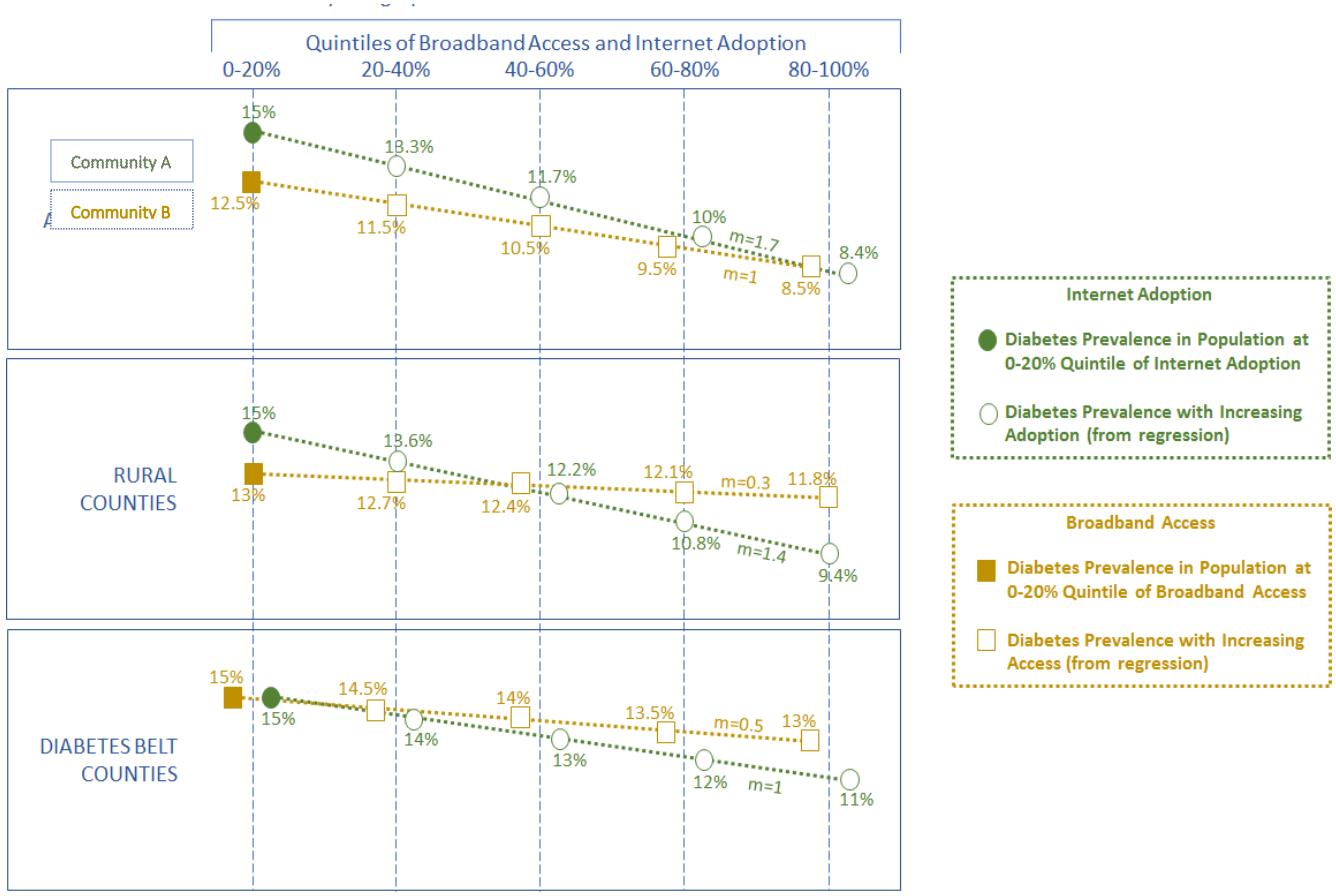
Modeling Improvements in Connectivity and Health

Next, we evaluated the potential impact of improving connectivity on health in poorly-connected communities. We sought to quantify the magnitude of connectivity-mediated health improvement among a population of people with diabetes. Figure 4 models the potential improvement in health as connectivity increases for all counties, rural counties, and high diabetes counties. The yellow dotted line represents how diabetes prevalence changes (i.e., decreases) as broadband *access* increases; the green line represents how diabetes prevalence changes (i.e. decreases) as Internet *adoption* increases.

First, we took Community A with broadband access in the 0-20% range (i.e., 8 out of every 10 people reportedly lack access) and diabetes prevalence of 12.5% (which is the current average prevalence reported for counties in that broadband access range).[11] Were that same community to improve its broadband access to 80-100%, the model indicates that its diabetes prevalence would tumble by one-third to 8.5%. Similarly, if Community B were to move from the 0-20% quintile for broadband *adoption* to the 80-100% quintile for adoption, its diabetes prevalence is theorized to decrease by about half, a shift from 15% to 8.4%. (*See* Figure 4).

[11] *See generally Centers for Disease Control and Prevention, National Diabetes Statistics Report, 2017. Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Services: 2017.*

Figure 4. Modeling Changes in Diabetes Prevalence as Broadband Access and Internet Adoption Increase, By Geography



We observed a similar pattern when looking at counties with majority rural population or those counties in the diabetes belt. For rural counties, the model indicates that a shift from 20% to 80% broadband access (i.e., moving from a broadband access profile where 2 out of every 10 people in the county have access to a profile where 8 out of 10 have access) might be associated with a 1.2% decrease in diabetes prevalence – from 13% to 11.8%. A similar increase in broadband adoption though would appear to yield bigger dividends, a full five percentage point drop in diabetes prevalence, from 15% to 9.4%.

Even among "diabetes belt" counties, the model suggests a 2-percentage point decrease in diabetes prevalence between the lowest and highest quintiles of broadband access; and a 4-percentage point drop between those same quintiles of broadband *adoption.*

To put this in better context, Mississippi and Kentucky are 2 of 15 states in the "diabetes belt."[12] Data from the Kentucky Behavioral Risk Factor Surveillance Survey (BRFSS) shows that from 2000 to 2015, diagnosed diabetes among adults has more than doubled from 6.5% (198,052) to the current rate of

[12] CDC scientists have identified a "diabetes belt"—644 counties—located mostly in the southern portion of the United States. States with a portion of their counties in the diabetes belt are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia and West Virginia. The entire state of Mississippi is included in the belt. *See "*CDC Identifies the Diabetes Belt," *available at* https://www.cdc.gov/diabetes/pdfs/data/diabetesbelt.pdf.

13.4% (458,381).[13] Based on CDC estimates, as many as 1 in 3 Kentucky adults (37% or 1.1 million) have prediabetes. In Mississippi, the picture is even bleaker. According to the Mississippi Department of Health, in 2015, Mississippi ranked first in the nation for overall diabetes prevalence, with over 333,026 adult Mississippians living with diabetes (over 14.7% of the adult population).[14] Given the high rates of diabetes, even relatively small reductions in prevalence can change the lives of tens of thousands of people.

The Broadband Connectivity Continuum

We emphasize that the above analysis and modeling examines *correlation*, not causation. Yet, causation is suggested by the data—likely through a web of interlinked and interacting social determinants of health such as education, job training, employment opportunities, and more that are made accessible by connectivity and which over time can positively impact health. For example, increasing connectivity can improve access to employment opportunities, which can improve access to health care, which can in turn improve health outcomes. Or, increasing connectivity can improve access to educational resources and learning outcomes, which can improve income and earnings, empower an individual towards self-management of health conditions, and improve health.

This is supported by the current data analysis in that there appears to be a "connectivity continuum" influencing health. In this "connectivity continuum," the most proximal relationship between connectivity and a given health outcome is tied to actual utilization of broadband connectivity for health. Distal to that is the broadband subscription (i.e., adoption) required for utilization; and further distal to that and with a smaller correlation with health outcomes is the existence of broadband infrastructure or "access," again a necessary pre-condition to other components.

In a valid "connectivity continuum" framework, one would expect that the more distal the factor from the measure of interest (in this case, health outcomes), the smaller its effect or correlation with the health outcome. Put another way, and as shown in Figure 5, if we start with the broader group of people who have access to broadband infrastructure in their community, a potential subgroup would subscribe to and adopt the high-speed Internet, and a smaller subset of that group would utilize it directly or indirectly for health (*See* Figure 5).

We saw this pattern in the early stages of the analysis. In Figure 1, higher quintiles of access correlate to a one-point lower diabetes prevalence. Given the current national average of 10% diabetes prevalence, this translates to a potentially 10% lower diabetes prevalence with each increasing quintile of broadband access. Compare that to Internet adoption metrics where each successively higher quintile of adoption correlates to 1.65 points lower diabetes prevalence – i.e., a 16.5% lower diabetes prevalence in communities for each subsequent quintile of adoption. The same general pattern holds true when we examine majority rural counties and for counties within the "diabetes belt" (*See* Figures 2, 3).

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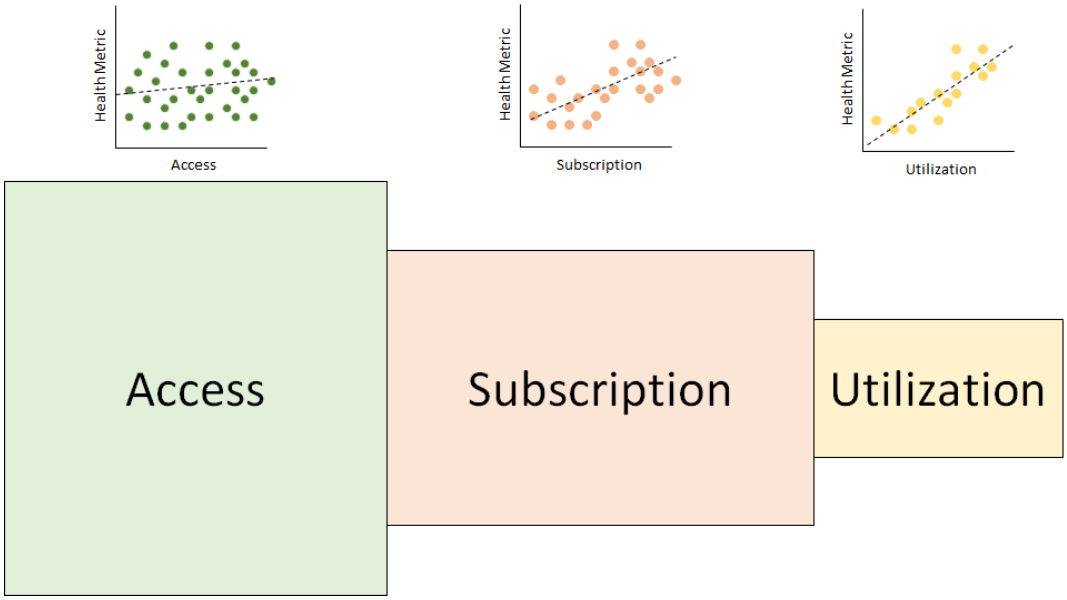
[13] *See* Kentucky Public Health, *2017 KENTUCKY DIABETES FACT SHEET – Diabetes: A Public Health Epidemic*, *available at* http://chfs.ky.gov/NR/rdonlyres/BB81CB18-30BE-4E18-B6E0-D8BF86266AC2/0/2017KYDiabetesFactSheetFINAL.pdf.

[14] *See* Mississippi State Department of Health, Diabetes in Mississippi ("Diabetes accounted for 1,091 deaths in Mississippi in 2015. In addition, many more Mississippians live with the complications of type 2 diabetes, including lower extremity amputations, end stage renal disease, blindness, loss of protective sensation, heart disease and premature death."), https://msdh.ms.gov/msdhsite/_static/43,0,296.html (last visited May 9, 2018).

Figure 5: The Broadband Health Continuum



The above analysis examines the correlation between connectivity and diabetes prevalence. It also looks at changes in diabetes prevalence given the hypothetical progression of a county through quintiles of connectivity using a statistical model. Or, more generally, it looks at how diabetes prevalence changes as potential factors that influence both connectivity and health change in a direction that improves both. The increasing magnitude of the relationship between health outcomes and stage along the Connectivity Continuum, the persistent pattern of a positive relationship across sub-populations even for historically underserved populations, and—as we will see below—the increasing reliance on connectivity to address social determinants of health, are all suggestive of a causal relationship between a community's level of connectivity and its health.

That said, we believe that additional study and analysis is urgently needed to confirm whether, and if so to what extent, a causal relationship exists between access to and adoption of broadband connectivity and health outcomes.[15] The policy implications of such a link would be seismic importance to both the technology and public health spheres.

Connectivity: Determinants of Social Determinants

Finally, the relevance of connectivity to health is not just a question of how often and how starkly it correlates to improved health outcomes, although the analysis above has significant implications standing

[15] In this regard, the Task Force has partnered with the Centers for Disease Control to further study the relationship between connectivity and health—recognizing that such a relationship, if causal, would have significant implications for both broadband policy and public health.

alone. It is also notable that in our information age many of the established social determinants of health —e.g., education, income, economic stability, social and community context[16]—are increasingly premised on broadband access and on the ability to connect to online activities and resources. Recent studies on connectivity barriers and why some Americans do not use the Internet have found that education and income are often-cited reasons.[17] Somewhat perversely though, improving one's level of education and maximizing your income in today's Internet economy often require connectivity.

- According to the Pew Research Center, 80% of Americans use online resources and information to search for jobs; 90% of recent job seekers have researched jobs; and 84% have applied for a job online. In fact, job seekers with lower levels of education are much more likely to use their smartphone to fill out a job application or create a resume or cover letter.[18]
- Many students rely on the Internet for learning and completing their schoolwork. Even among low- and moderate- income families, 81% of early teens who use the Internet, report using it to complete homework, and about 40% use it to connect with teachers and talk to other students about school projects.[19]
- As to community engagement and civic participation, according to Pew, 17% of American adults have signed a petition online; 18% have recently contacted a government official about an issue that is important to them online, by email, or by text message; and 8% have commented on an online news story or blog post to express an opinion about a political or social issue.[20]

We recognize that the above statistics are a reflection of user behavior and requirements of the

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[16] *See* Office of Disease Prevention and Health Promotion, Social Determinants of Health (noting that health starts in our homes, schools, workplaces, neighborhoods, and communities and that the Social Determinants of Health topic area within Healthy People 2020 is designed to identify ways to create social and physical environments that promote good health for all), https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health (last visited 5/9/2018).

[17] *See* Monica Anderson, *Digital divide persists even as lower-income Americans make gains in tech adoption*, Pew Research Center (Mar 22, 2017), http://www.pewresearch.org/fact-tank/2017/03/22/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption/.

[18] *See* Aaron Smith, *Pew Research Center, Searching for Work in the Digital Era, Pew Research Center* (Nov. 19, 2015), http://www.pewinternet.org/2015/11/19/searching-for-work-in-the-digital-era/

[19] *See* Alina Selyukh, *How Limited Internet Access Can Subtract From Kids' Education*, National Public Radio (Feb 2, 2016), http://www.npr.org/sections/alltechconsidered/2016/02/06/465587073/how-limited-internet-access-can-subtract-from-kids-education; Victoria Rideout, Vikki Katz, *Opportunity for all? Technology and learning in lower-income families* (2016), *available at* http://digitalequityforlearning.org/wp- content/uploads/2015/12/ jgcc_opportunityforall.pdf. For education, connectivity offers more than a supplemental role. When seven in ten teachers assign homework that requires web access, connectivity becomes critical to achieving an education and preventing a "homework gap" which threatens to leave children from poorly-connected communities behind. *See* Cecilia Kang, *Bridging a Digital Divide That Leaves Schoolchildren Behind*, The New York Times (Feb. 22, 2016), available at http://www.nytimes.com/2016/02/23/technology/fcc-internet-access-school.html?_r=0 . In places where connectivity is poor, students use mobile phones to access their school WiFi to download assignments. And in some communities (*e.g.*, in places in Rio Grande Valley, an area that the Task Force has also visited), students take longer bus routes so they have more time to access the WiFi on their bus to study and complete their work, or they frequent fast-food restaurants that offer free WiFi in order to study for tests. *See id*. *See also* Astrid Martinez, *Wi-Fi turns school bus into rolling study hall*, Station KGBT-TV News (May 17, 2012), http://valleycentral.com/news/local/wi-fi-turns-school-bus-into-rolling-study-halll.

[20] *See* Aaron Smith, *Civic Engagement in the Digital Age*, Pew Research Center (Apr 25, 2013), http://www.pewinternet.org/2013/04/25/civic-engagement-in-the-digital-age/.

information age. However, while many Americans may use the Internet to search for jobs, jobs may conversely require applicants to use the Internet to apply (e.g., to submit an application online or follow-up through email).

Table 2 below summarizes our findings related to the relationship between connectivity and health for communities across the U.S. showing that: (1) there is a direct causal relationship between connected technologies and health; (2) connected health technologies are premised on consumer subscription to connectivity and its existence as ubiquitous infrastructure in the environment; (3) connectivity is associated and correlates with health outcomes; (4) the association between connectivity and health outcomes could well be explained by a third set of factors that impact both—for example, income, education, job opportunities, etc., (i.e., social determinants of health); and (5) even, in that case, addressing those social determinants of health are also premised on connectivity.

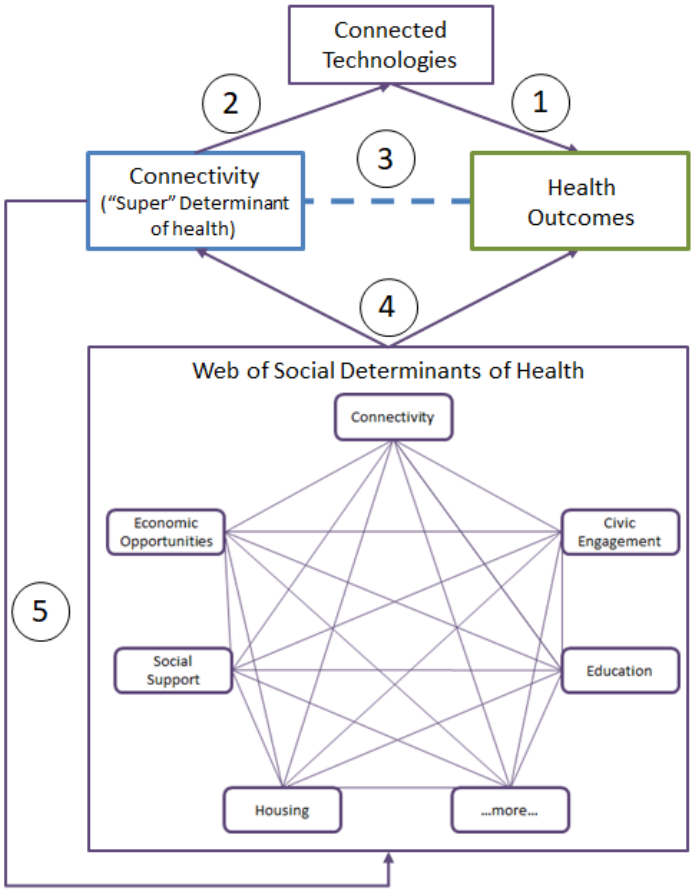
To simplify, the analysis shows that it is connectivity's potential impact on health plus its status as a determinant of other determinants of health that necessitate its classification as a "super" determinant of health. Conversations with local communities and research continue to show that digital exclusion is most commonly attributed to lack of digital literacy, lack of perceived relevance, and high cost. This was a theme that consistently emerged during the Task Force's Beyond the Beltway visits to communities across the U.S. But, if these barriers to connectivity exist, and if connectivity is a determinant of other social determinants that digitally-excluded communities also lack, then it stands to reason that communities might end up in a vicious cycle where, for example, digital exclusion leads to low access to employment and job training, which in turn (or at first) leads to further digital exclusion, and, which, in a vicious cycle leads to lower access to employment, job training, entrepreneurship and other social determinants required to achieve health and opportunity.[21]

This same observation of digital exclusion and lack of access to opportunities for employment, job training, and education was highlighted in our visits to urban Detroit, rural Virginia, and rural Mississippi. Connectivity, it seems, exerts its influence as a social determinant almost universally where it is accessible with sufficient capacity to offer access to other determinants of health.

Yet, the power of connectivity is that communities can use it to flip the script. Connectivity can become the link in the downward spiral that can be intervened upon to create an upward spiral of opportunity and health. Recognizing connectivity as a "super" determinant of health means that communities connecting to health are additionally connecting to the many other social determinants of health that form a network of relationships between health and opportunity.

[21] *See* Fran Baum, Lareen Newman, and Katherine Biedrzycki, *Vicious cycles: digital technologies and determinants of health in Australia*, 29 Health promotion international 349 (2012).

Table 2: Summary of Relationships Between Connectivity and Health



① There is a direct and established causal relationship between the use of connected technologies and individual health outcomes. (*See* notes 96-99, *infra* and accompanying text.

② Broadband access and adoption are a necessary predicate to leveraging connected technologies, pointing to connectivity as a social determinant of health.

③ Health outcomes are associated with and correlate with levels of connectivity in a community, additionally pointing to connectivity as a social determinant of health. (*See* Figures 1-4 above).

④ The association between connectivity and health outcomes could be explained by a set of factors that affect both (e.g. income, education, job opportunities, and other social determinants of health).

⑤ Social determinants of health are also premised on connectivity.

In conclusion, this section demonstrates the key point that broadband has impacts on health and care far beyond the direct effects of enabling clinical care and applications like remote patient monitoring.[22]

[22] We recognize that the relationship between broadband and health is complex and has both direct and indirect components. While correlations between connectivity and health can be understood to be mediated by a set of factors that improve both connectivity and health, we also see that these same factors are also reciprocally determined by connectivity. Because of the necessity of connectivity to achieve social determinants of health, communities at different levels of connectivity would have different strengths of webs of social determinants: poorly connected communities may not have the job training and entrepreneurship opportunities facilitated by a well-connected community. Because a major determinant of chronic diseases are the socio-economic conditions

Broadband in a community can have an impact on a community's health and well-being by increasing access to the social determinants of health. In communities that have poor access to social determinants in their physical environment, broadband can bring opportunity and health directly into the homes of each person and, in the process, transform the health status and improve the quality of life of entire communities.

and determinants in the community, then one can see how when connectivity improving webs of socio-economic opportunities would improve the health outcomes of a community.